

# **Subsidence Monitoring and Mitigation for Sustainability and Improved Water Management in the Sacramento–San Joaquin Delta**

**Desiree A Brun**

## **Public Comments**

No public comments were received for this proposal.

# Initial Selection Panel Review

## Proposal Title

#0304: Subsidence Monitoring and Mitigation for Sustainability and Improved Water Management in the Sacramento–San Joaquin Delta

## Funding:

Do not fund

## Initial Selection Panel (Primary) Review

### Topic Areas

- Implications Of Future Change On Regional Hydrology, Water Operations, And Environmental Processes

Please describe the relevance and strategic importance of this proposal in the context of this PSP. How does the proposal address the topic areas identified above? What are the broader CALFED Goals this proposal may meet that are not accounted for in these specific topic areas?

The proposed project has relevance to the the performance assessment priority topic area. The project proponents state the project will also provide information of substantial use to issues of water quality and ecosystem restoration, but I think this is a bit of a stretch. The proposal does provide information directly relevant to the CALFED goal of levee system integrity.

The budgets of proposals submitted in response to this PSP are larger, on average, than those submitted to CALFED in previous years. The Science Program is committed to getting as much science per dollar as is reasonably possible. With this commitment in mind, can the proposed budget be streamlined? If so, please recommend and clearly justify a new budget total in the space provided.

As pointed out in the technical reviews, the budget for this project seems too high.

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## Initial Selection Panel Review

### Evaluation Summary And Rating.

Provide a brief explanation of your summary rating and any additional comments you feel are pertinent.

I cannot recommend funding this project without seriously rescoping the project based on comments from the technical reviewers. I do not think the results will have general applicability across the delta, based on the study design (i.e., use of fallowed areas and limited replication). The approach is not well documented in several places, so the budget is not well supported. Although the proposal addresses a critical issue, I am not convinced that expenditure of ~\$2 million on this project will substantially advance our knowledge or help agency managers make the very tough decisions that will need to be made in the CALFED timeframe.

### Selection Panel (Discussion) Review

fund this amount: \$0

note:

do not fund

This proposal addresses issues of critical importance to CALFED. However, previous technical reviews and the review of the technical panel raised significant methodological and analytical concerns that the Selection Panel also found troubling. Specifically, the technical reviewers had substantial questions regarding: the applicability and efficacy of the remote-sensing work, the unlikely potential for altered crop use to reduce subsidence, and broader applicability of the results.

The Selection Panel could not recommend funding without answers to these questions. If these questions and the other comments from the technical reviewers can be successfully addressed, the selection panel recommends the proponents seek funding through CALFED levees program in relation to the Delta Risk Management Strategy.

## Initial Selection Panel Review

**Panel Ranking: Do not fund**

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# Technical Synthesis Panel Review

## Proposal Title

#0304: Subsidence Monitoring and Mitigation for Sustainability and Improved Water Management in the Sacramento–San Joaquin Delta

Final Panel Rating
above average

## Technical Synthesis Panel (Primary) Review

### TSP Primary Reviewer's Evaluation Summary And Rating:

This is a generally strong proposal that seeks to monitor subsidence rates in the Delta and explore a potential strategy for mitigating subsidence. The investigators make a strong case for the importance of studying and mitigating subsidence due to its potential impact on levee integrity and flood conveyance through the Delta. Study goals are to: 1) test a remote sensing technique for spatially explicit quantification and monitoring of subsidence; 2) explore alternative crop use (rice vs. corn) as a means of retarding subsidence due to microbial oxidation of soil organic carbon (identified as the primary cause for subsidence); and 3) evaluate the water-quality impacts of changing land use from corn to rice cultivation. The investigators present a well-developed conceptual model justifying their proposed work and relate project goals to several CALFED programs. They propose a combination of established and novel measurement techniques (e.g., sedimentation erosion tables vs. InSAR/CTM to record land surface elevation changes). The project has a high likelihood of success and should provide useful information for monitoring and potentially mitigating Delta subsidence. Primary criticisms are: 1) limited number of study sites and consequent uncertainty in extrapolating results to the Delta in general; 2) focus of InSAR/CTM work on fallow fields

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## Technical Synthesis Panel Review

(atypical of the Delta) and no test of this remote sensing technique in more typical land types (vegetated); 3) vague/incompletely explained methods in some instances; 4) subsidence unlikely to be reversed, as claimed, through altered crop use; and 5) potential trade-off between arresting surface subsidence via rice cultivation versus increased subsidence due to groundwater pumping for this crop (however, unclear that rice cultivation involves groundwater pumping). Despite these criticisms, this is a valuable pilot study that addresses an important issue that is highly relevant to CALFED programs and tests novel measurement techniques. The PIs are capable and qualified, and the budget seems reasonable.

### Additional Comments:

This is a generally strong proposal that seeks to monitor subsidence rates in the Delta and explore a potential strategy for mitigating subsidence. The investigators make a strong case for the importance of studying and mitigating subsidence due to its potential impact on levee integrity and flood conveyance through the Delta. Study goals are to: 1) test a remote sensing technique for spatially explicit quantification and monitoring of subsidence; 2) explore alternative crop use (rice vs. corn) as a means of retarding subsidence due to microbial oxidation of soil organic carbon (identified as the primary cause for subsidence); and 3) evaluate the water-quality impacts of changing land use from corn to rice cultivation. The investigators present a well-developed conceptual model justifying their proposed work and relate project goals to several CALFED programs. They propose a combination of established and novel measurement techniques (e.g., sedimentation erosion tables vs. InSAR/CTM to record land surface elevation changes). The project has a high likelihood of success and should provide useful information for monitoring and potentially mitigating Delta subsidence. Primary criticisms are: 1) limited number of study sites and consequent uncertainty in extrapolating results to the Delta in general; 2) focus of InSAR/CTM work on fallow fields (atypical of the Delta) and no test of this remote sensing technique in more typical land types (vegetated); 3)

## Technical Synthesis Panel Review

vague/incompletely explained methods in some instances; 4) subsidence unlikely to be reversed, as claimed, through altered crop use; and 5) potential trade-off between arresting surface subsidence via rice cultivation versus increased subsidence due to groundwater pumping for this crop (however, unclear that rice cultivation involves groundwater pumping). Despite these criticisms, this is a valuable pilot study that addresses an important issue that is highly relevant to CALFED programs and tests novel measurement techniques. The PIs are capable and qualified, and the budget seems reasonable.

## Technical Synthesis Panel (Discussion) Review

### TSP Observations, Findings And Recommendations:

This is a generally strong proposal that seeks to monitor subsidence rates in the Delta and explore a potential strategy for mitigating subsidence (an important factor affecting levee integrity). The external technical reviewers and the panel agreed that the proposed research was compelling and addressed important topics, and that the results are likely to be useful. However, the reviewers made a number of substantive comments that if addressed would improve the proposed research (e.g., regarding the small sample size for field sites, and testing the remote sensing in vegetated sites (typical Delta land types) in addition to fallow fields). The panel also found the budget to be high for the proposed work. Despite these criticisms, the panel found this to be an important, timely project and rated it Above Average.

# Technical Review #1

proposal title: Subsidence Monitoring and Mitigation for Sustainability and Improved Water Management in the Sacramento–San Joaquin Delta

## Review Form

### Goals

Are the goals, objectives and hypotheses clearly stated and internally consistent? Is the idea timely and important?

Comments	This is one of the best-defined proposals I have ever reviewed. The goals are clearly stated and the hypotheses well tested. I also believe that there is an excellent chance for successfully achieving the proposed goals.
Rating	excellent

### Justification

Is the study justified relative to existing knowledge? Is a conceptual model clearly stated in the proposal and does it explain the underlying basis for the proposed work? Is the selection of research, pilot or demonstration project, or a full–scale implementation project justified?

Comments	The research is new and necessary. Even if the results are not as anticipated, we need to know if these techniques/approaches are feasible. The authors did a good job of making sure that their research will be applicable to large scale landscape assessments. The work is justified and important.
Rating	excellent

### Approach

Is the approach well designed and appropriate for meeting the objectives of the project? Is the approach feasible? Are results likely to add to the base of knowledge? Is the project likely to

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## Technical Review #1

generate novel information, methodology, or approaches? Will the information ultimately be useful to decision makers?

Comments	The approach is very sound. The use of proven ground sampling techniques (e.g., SETs, groundwater wells) with newer applications (e.g., CTMs and INSAR) will provide valuable results even if the newer applications don't pan out as anticipated. The application to the management option (rice cultivation) is based on a sound wetland response to flooding and subsidence that is well supported in both European and American literature. Even if rice cultivation does not prove to be a proper management option, the knowledge from such an attempt is worth the effort.
Rating	excellent

## Feasibility

Is the approach fully documented and technically feasible? What is the likelihood of success?  
Is the scale of the project consistent with the objectives and within the grasp of authors?

Comments	Any time new techniques are proposed, there is a chance for failure (can INSAR accurately follow subsidence rates of only a few centimeters). However, if it does work and the technique can be adopted, this tool will have an important application to CALFED and other regions as well. The authors have laid out a technical proposal that is consistent with the objectives and well within their area of expertise. Further, the use of agriculture to slow subsidence is something that could prove to be important economically as well as environmentally. We know that we cannot turn back the hands of time to pre-Gold Rush days and therefore we need to continue to apply our knowledge forward and develop land-use management techniques that solve multiple problems on the landscape.
Rating	excellent

## Technical Review #1

### Monitoring

If applicable, is monitoring appropriately designed (pre–post comparisons; treatment–control comparisons)? Are there plans to interpret monitoring data or otherwise develop information?

Comments	As any scientist would say, there is never enough monitoring proposed. It would be nice to see a multi-decadal monitoring program proposed but that is often not feasible. I am confident that the researchers will continue to monitor this activity long after this grant would end. Certainly the information they are going to collect will lend itself to long-term monitoring relatively easy and the fact graduate students are always looking for a research project; however, that is something that has not been discussed within this proposal.
Rating	very good

### Products

Are products of value likely from the project? Are contributions to larger data management systems relevant and considered? Are interpretive (or interpretable) outcomes likely from the project?

Comments	Success or Failure will be valuable here. The information the authors will collect will allow for assessment either way (if it does not work they will be able to determine why and possibly fix the approach or determine that it is not feasible). Therefore, the product of this research will be valuable to all future endeavors of this type.
Rating	excellent

### Additional Comments

Comments	The approach to subsidence is long overdue. This field of investigation has been largely ignored and, as the authors pointed out, is paramount to our understanding
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## Technical Review #1

	and management of these areas as relative sea level rise continues to become a major process of the landscape. This work has the potential to do much more than just advance our understanding of subsidence and sea level rise it could also provide us with a relatively inexpensive method for following land subsidence over large swaths of land. One word of caution, we have found that drained lands that are once again flooded can cause acidification of the soils and remobilize quantities of heavy metals and nutrients once trapped by the oxidized chemistry of these systems. The authors may want to monitor these changes as well.
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### Capabilities

What is the track record of authors in terms of past performance? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project?

Comments	It appears by their CVs and discussions presented within this proposal that the authors are very qualified for this research. They have already laid much of the theoretical and experimental ground work for this proposal and appear to understand the problems and approaches that are necessary to achieve success. The fact that they will be using this project to train future scientists is a big plus for this proposal.
Rating	excellent

### Budget

Is the budget reasonable and adequate for the work proposed?

Comments	I have been doing research for over twenty years and I still haven't gotten used to the costs that projects incur these days. The money that is being proposed here does seem to be a lot of money, but then again, if successful, could end up saving CALFED and land
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#### Technical Review #1

	managers much more money in the future. Since some of the money will go to helping pay Graduate students, the investment goes beyond the tangible associated directly with the products of this proposal.
<b>Rating</b>	very good

### Overall

Provide a brief explanation of your summary rating.

<b>Comments</b>	The proposal was well thought out and clearly presented. Both old and new techniques are going to be tested and the research is well balanced. The work will have application to scientists, land managers and even economists and the information will be important to know one way or the other. This is one of those rare times where success or failure will result in important information.
<b>Rating</b>	excellent

# Technical Review #2

proposal title: Subsidence Monitoring and Mitigation for Sustainability and Improved Water Management in the Sacramento–San Joaquin Delta

## Review Form

### Goals

Are the goals, objectives and hypotheses clearly stated and internally consistent? Is the idea timely and important?

Comments	The objectives, hypotheses, and questions asked are internally consistent. It is clear what they want to do, although the poor writing at various points prevents them from making clear, concise, readable statements of their objectives (e.g., "determine the potential for stopping and reversing the effects of subsidence of Delta rice cultivation" - almost sounds like they are worried about the subsidence of Delta rice cultivation!). I wholeheartedly endorse their general goal of improving our understanding of the processes that lead to subsidence and the linkages to flooding regime and carbon balance. Subsidence does seem like one of the most important issues facing the Delta, and the suggestion that shifting to large-scale rice cultivation might mitigate this problem seems reasonable and very worth pursuing. I am not convinced that the effort put into remote sensing to measure elevation change is worthwhile (more below).
Rating	very good

### Justification

Is the study justified relative to existing knowledge? Is a conceptual model clearly stated in the proposal and does it explain the underlying basis for the proposed work? Is the selection of research, pilot or demonstration project, or a full–scale implementation project justified?

## Technical Review #2

Comments	The proposal builds effectively on existing knowledge, especially previous studies on carbon balance and elevation change in the Delta. However, the authors do ignore results and approaches taken in other systems to understand subsidence; I am thinking especially of results from salt marshes and other wetlands using sediment-elevation tables (SETs) and radiometric dating (e.g., $^{210}\text{Pb}$ ). The conceptual model is generally stated fairly clearly, though the linkages between rice cultivation and water quality issues are never clearly elaborated. The authors spend too long on the justification section, which is repetitive and general, at the expense of providing necessary detail on what they will do (see below).
Rating	good

## Approach

Is the approach well designed and appropriate for meeting the objectives of the project? Is the approach feasible? Are results likely to add to the base of knowledge? Is the project likely to generate novel information, methodology, or approaches? Will the information ultimately be useful to decision makers?

Comments	The general approach consists of: remote sensing of elevation change; field measurements of elevation change; field and lab measurements of carbon budgets; and field measurements of water quality. In general, I think most of these approaches are reasonable, although my sense (admittedly not as a remote sensing expert) is that the remote sensing methodologies they are investigating are unlikely to result in a feasible method for measuring elevation change at relevant resolution over relevant spatial scales. As they point out, previous work with InSAR has shown it to be inapplicable to vegetated areas; their solution to this problem - the use of fallow areas - is an artificial manipulation which is likely to change elevational processes. CTM focuses on anthropogenic structures, but do these accurately reflect subsidence in vegetated areas? The answer depends on how deeply
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## Technical Review #2

	sunk the structures are. The authors suggest that CTM may also capture the elevation change in "adjacent" vegetated land, but it was unclear to me what they meant by adjacent (presumably within the 5x10m pixel size?) and how relevant those results would be.
Rating	good

## Feasibility

Is the approach fully documented and technically feasible? What is the likelihood of success?  
Is the scale of the project consistent with the objectives and within the grasp of authors?

Comments	<p>This is the greatest weakness of this proposal. In my opinion, they do not give enough detail on what they plan to do, how they plan to do it, and how it will answer the questions posed. The types of activities they describe are, to my mind, mostly quite feasible, but we are not given enough information about how they plan to do them. This is most problematic for the activities that they simply mention once or twice without elaborating, especially the use of stable and radioactive isotopes to trace water ages and carbon dynamics, and the use of SETs. More detail is also needed on the timing and the spatial and temporal frequency of the different activities (how many fields of rice and corn on each island, how many plots within each field, how frequently sampled, how many CT time points will they have within 2 years, do they have the sampling frequency and spatial resolution to carry out the carbon budgets they propose, etc). They talk of evaluating rice, corn, and "wetlands," but nowhere do they state clearly where the wetland plots are (the fallow fields on Sherman and Twitchell islands?). In general, the tasks section is sloppy and poorly written, which to my mind suggests that they have not thought through the details carefully enough at this stage. I provide just 2 examples out of many: the second bullet in Task 6 is missing words and seems to be the same as the third bullet; and Figures 6a and 6b correspond to different levels of detail, not a</p>
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## Technical Review #2

	difference between aerobic and anaerobic soils. The lack of detail and sloppiness in this section means that it is hard to evaluate the likely success of the project: it largely comes down to whether you trust the abilities of the PI's, once funded, to implement a reasonable project.
Rating	fair

## Monitoring

If applicable, is monitoring appropriately designed (pre–post comparisons; treatment–control comparisons)? Are there plans to interpret monitoring data or otherwise develop information?

Comments	N/A
Rating	not applicable

## Products

Are products of value likely from the project? Are contributions to larger data management systems relevant and considered? Are interpretive (or interpretable) outcomes likely from the project?

Comments	The most valuable product that is likely to emerge from this project is a sense of the carbon budgets for rice and corn fields and how they relate to elevation change and DOC export. This would provide the understanding necessary for deciding whether to proceed further with the idea that rice cultivation might be a solution to the subsidence problem.
Rating	very good

## Additional Comments

Comments
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## Technical Review #2

### Capabilities

What is the track record of authors in terms of past performance? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project?

<b>Comments</b>	The PI's and their associates appear to be well-qualified to carry out this research. The team covers the different disciplines necessary.
<b>Rating</b>	very good

### Budget

Is the budget reasonable and adequate for the work proposed?

<b>Comments</b>	The budget is a little hard to evaluate, given the lack of clarity on the specific tasks to be carried out. But it generally appears to be reasonable (though some of the labor could probably be reduced).
<b>Rating</b>	very good

### Overall

Provide a brief explanation of your summary rating.

<b>Comments</b>	The project addresses a very important area, and the general approach is sound (with the possible exception of the remote sensing work). However, the sloppiness of the proposal and the lack of clear explanation of the task details don't bode well for the success of the project.
<b>Rating</b>	good

# Technical Review #3

proposal title: Subsidence Monitoring and Mitigation for Sustainability and Improved Water Management in the Sacramento–San Joaquin Delta

## Review Form

### Goals

Are the goals, objectives and hypotheses clearly stated and internally consistent? Is the idea timely and important?

Comments	<p>Yes, I think they are clearly stated and consistent. The proposal addresses the three CALFED programs, Water Quality, Ecosystem Restoration and Levee System Integrity. Priority 3 addressed by--proposing to develop ways to better measure the temporal and spatial variability of subsidence in the Delta using satellite data and imagery analysis (InSar and CTM). Priority 2 addressed by--stopping and reversing the effects of subsidence by evaluating induced-flooding as part of rice cultivation as a land use practice that is hypothesized to stop and/or reverse the effects of subsidence. Further, proposed to address how can rice cultivation and wetlands be effectively integrated into island land and water management to minimize water-quality effects, primarily minimization of DOC loads to Delta channels?</p> <p>Is the idea timely and important? Yes, proposal points out levees currently stressed due to subsidence and that levee failure could occur with increased stress during seismic or flood event.</p>
Rating	excellent

### Justification

Is the study justified relative to existing knowledge? Is a conceptual model clearly stated in the proposal and does it explain the underlying basis for the proposed work? Is the selection

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### Technical Review #3

of research, pilot or demonstration project, or a full-scale implementation project justified?

Comments	<p>Is the study justified relative to existing knowledge? Proposal established that subsidence is a significant problem, produced primarily by oxidation of organic soils. Problem is worse on islands because of agricultural drainage, but subsidence affects all of delta area, including all of levees. Levee failures could occur during flooding when levees are most stressed. Levee failure will disrupt CA Water Project, as in the 1972 flood.</p> <p>Is a conceptual model clearly stated in the proposal and does it explain the underlying basis for the proposed work? The current model for the Delta is one of static conveyance features, primarily in the form of 1,100 miles of levees. This study addresses need to adapt an alternative highly dynamic model for Delta conveyance that accounts for ongoing change: slow changes due to subsidence causing increased island accommodation space and deferred maintenance; rapid changes that may result from a highly probable large seismic event or floods. The primary missing piece of information is the lack of current elevation-change data, in particular its spatial variability, on Delta islands prevents the necessary quantitative assessment needed for future predictions.</p> <p>Proposal claims that induced flooding, via rice farming, may be able to stop and reverse subsidence. Conceptually, I believe it is possible to stop subsidence; however, the burden of proof is on the authors to show at what depths the subsidence is occurring and if short-termed near surface flooding has any affect on ceasing this process. If the amount of subsidence predicted by carbon flux matches actual subsidence then fine, but study does not go beyond this and look at subsidence by groundwater withdrawal.</p> <p>Is the selection of research, pilot or demonstration project, or a full-scale implementation project</p>
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### Technical Review #3

	<p>justified? For testing the hypothesis "Can InSar can identify subsidence?", study plans to use 5 100-acre parcels on State-owned Twitchell and Sherman Islands where land managers will fallow and maintain vegetation free areas. I question whether studying these very localized study areas will yield the type or enough data that can be applied across the Delta. They will know what is happening on these islands, but question the applicability to the entire Delta. Thus, I believe that the study should have been constructed to be more applicable to real Delta-like land-use conditions and it also should have been more geographically widespread across the Delta</p> <p>Carbon study is a local study on each of the three islands.</p>
Rating	very good

## Approach

Is the approach well designed and appropriate for meeting the objectives of the project? Is the approach feasible? Are results likely to add to the base of knowledge? Is the project likely to generate novel information, methodology, or approaches? Will the information ultimately be useful to decision makers?

Comments	<p>Is the approach well designed and appropriate for meeting the objectives of the project? Is the approach feasible? Yes, it is feasible to measure subsidence with InSar/CTM., set up carbon flux measurements to measure contribution to subsidence.</p> <p>Are results likely to add to the base of knowledge? Is the project likely to generate novel information, methodology, or approaches? Yes, we should learn if InSar can be used on these test plots and learn about the carbon flux and its contribution to subsidence on these islands</p>
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### Technical Review #3

	<p>Will the information ultimately be useful to decision makers? It will be useful if the method can be shown to be applicable to the entire Delta area, rather than just to isolated test plots (i.e., can the bugs be worked out of the predictive model by widescale use of CTM and knowing how to handle the groundwater affects)</p> <p>One final note, I ranked this a "fair" because of my discussion on groundwater and subsidence that is in the "Additional Comment" Section below. If groundwater withdrawal is not an issue then the "fair" ranking here in "Approach" could be raised.</p>
Rating	fair

## Feasibility

Is the approach fully documented and technically feasible? What is the likelihood of success?  
Is the scale of the project consistent with the objectives and within the grasp of authors?

Comments	<p>Is the approach fully documented and technically feasible? The approach is feasible here on a this controlled basis, but the difficulty will be applying this across the Delta where there is vegetation and constant disruption of the ground surface by agriculture. This will limit the InSar approach to a reliance on CTM. And it is unknown how to apply this remotely-sensed data (that is relatively easy to assess) across the Delta, without detailed groundwater elevation data (that is difficult to obtain and where the quality of the data could be questionable). Thus, as the technology currently exists, I question the widespread usefulness of this technique in areas away from structures, such as very rural farmland.</p> <p>What is the likelihood of success? I think that good subsidence data will be produced from these test areas. I question the widespread applicability outside</p>
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### Technical Review #3

	<p>of these "controlled situations" without fallowed non-vegetated ground and without groundwater data. This is especially true in very rural areas with few structures. On the mitigation part, I think that flood-induced mitigation via rice farming will slow or stop additional subsidence, but I do not believe that reversal of subsidence will occur.</p> <p>Is the scale of the project consistent with the objectives and within the grasp of authors? Yes, I believe that the scale is achievable.</p>
Rating	excellent

## Monitoring

If applicable, is monitoring appropriately designed (pre–post comparisons; treatment–control comparisons)? Are there plans to interpret monitoring data or otherwise develop information?

Comments	<p>Yes, as far as it goes monitoring seems sufficient. This study will document seasonal land surface changes in local areas using CMT/InSar. It has a detailed Carbon flux aspect to the study. I question why continuous GPS is not being considered to enhance this remotely sensed data. The authors state that GPS is "annual" rather than seasonal data, but GPS has been shown to pick up seasonal groundwater induced surface variations in the LA Basin (Hudnut et al). GPS is currently being used in the Firebaugh and Mendotta area to provide surveying control in areas that have experienced significant subsidence. And GPS is "ground-truth" real-time data. I would suggest checking with the regional EarthScope Plate Boundary Observatory (PBO) regional engineer to see what stations are planned for the area during the next 2 years. Real time GPS data would enhance your study and PBO might welcome an instrument location in the Delta as part of another study that screens out groundwater affects.</p>
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### Technical Review #3

	Also, as mentioned above, based on the unstated depths of the planned monitoring wells, I could not determine what depth aspect of the groundwater regime was being monitored (upper 10 ft)?
<b>Rating</b>	very good

## Products

Are products of value likely from the project? Are contributions to larger data management systems relevant and considered? Are interpretive (or interpretable) outcomes likely from the project?

<b>Comments</b>	<p>Are products of value likely from the project? Yes, using the CMT/InSar combination as a subsidence monitoring tool in the Delta is a defined and usable product. Documenting flooding from rice farming as a subsidence mitigation is a defined product, especially if it relates surface elevation change to the groundwater change.</p> <p>Are contributions to larger data management systems relevant and considered? No, I do not think that the application of this technique, as presented here, can be applied across the Delta. This is an attempt to develop the technique in a controlled situation and in one area of the Delta. The problem of subsidence across the Delta is discussed, but using this technique across the Delta is not considered as part of this study (it's only alluded to as a possible advantage).</p> <p>Are interpretive (or interpretable) outcomes likely from the project? Yes, I believe that this study will develop a good data set for the controlled study areas. Some aspects may be able to be extrapolated (interpretable) to other areas of the Delta.</p>
<b>Rating</b>	very good

## Additional Comments

Comments	<p>Proposal claims that induced flooding, via rice farming, may be able to stop and reverse subsidence. Conceptually, I believe it is possible to stop subsidence; however, the burden of proof is on the authors to show at what depths the subsidence is occurring and if short-termed near surface flooding has any affect on ceasing this process. If the amount of subsidence predicted by carbon flux matches actual subsidence then fine, but study does not go beyond this and look at subsidence by groundwater withdrawal.</p> <p>I take issue with the term "reversing" the subsidence process that is used throughout this proposal. Subsidence includes several aspects and, for example, consolidation from expelling water from fine-grained clastic sediments is not considered to be a reversible process. In this study with a focus on organics it seems that subsidence is offset by addition of carbon to a different area of the system (at the surface), but carbon that was lost in the subsurface is not replaced in the subsurface. This describes a sedimentation process that offsets subsidence, but it does not reverse the subsidence process. Once organic soils have consolidated they do not "unconsolidated or re-hydrate" and produce elevation gains. It would be more accurate to refer to this as offsetting the subsidence.</p> <p>Another aspect of the subsidence issue is producing water to flood the fields. The authors discuss organic flux as the primary natural cause of subsidence, but they do not discuss groundwater withdrawal affects. Groundwater withdrawal is one of the best documented causes of subsidence (e,g., Mendotta). The source of the water is not discussed. Is this source surface water or groundwater? If groundwater is used for flooding then is the source local and from site wells? If it is obtained by local wells, then increasing pumping to produce water to flood fields produces a</p>
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### Technical Review #3

new potential source of subsidence The authors do not discuss the negative affect of pumping on subsidence, nor do they discuss how to screen out its complicating affects on their study. If this issue could be clarified then perhaps we can reduce concern, however, until they are clarified these could be potentially big issues that are not being considered adequately in the proposal.

Monitoring wells are discussed, but how they are constructed was not discussed (Bouldin Island will have 6-10 wells at various depths, existing wells on Twitchell Island, but no discussion of wells on Sherman Island). I realize that details like this may not be appropriate for the proposal, but my concern is that the complexity in the groundwater regime and its affect on subsidence is not being fully investigated. I would want to know if pumping wells are being used to supply the flood water. Where are the monitoring wells and the observations plots relative to these wells? If pumping wells are being used, then at what depth is the screened interval? What is the general anticipated depth of the monitoring wells? What is the screened interval? How much blank (unscreened interval) will be installed from the surface and how will the screen be isolated from surface affects? Also, at least conceptually, the depth/length of extensimeters should be discussed (1 ft?, 5 ft?, 10ft?, 20ft?, 50ft?, or ??????). This tells the reviewer where the subsurface aspect of the study is focusing - based on other data it would seem the upper 5-10ft?. Note that none of the graphics indicated a depth from the surface or a vertical scale (only vertical flux in water level and surface elevation was shown). As another comment on comparing corn and rice farming, with the statement that "rice is more profitable than corn," the authors should clarify that all cost aspects of farming were taken into account. For example, were process costs of pesticides, fertilizers, labor, difference in equipment costs, irrigation, etc., factored in or was the market price

### Technical Review #3

	of corn versus rice used? Without factual documentation showing that rice is more profitable than corn or other crops, this statement seems just tossed out. I am sure the authors will address this by the Farmer Outreach process, but it was not clear to this reviewer. Farming is a much a culture as it is a process, and getting the agricultural industry to adopt new approaches must be well documented and factual. The authors just need to factually document a statement such as this because it can be a powerful argument for their study.
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## Capabilities

What is the track record of authors in terms of past performance? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project?

Comments	<p>What is the track record of authors in terms of past performance? Very Good. Cumulatively they have several currently funded studies by SWQCB or Calfed-DWR regarding subsidence in the Delta area Contra Costa Water District is currently funded on a SWQCB proposal (\$869K) to study "Reducing NonPoint Dissolved Organic Carbon and Nitrogen Exports From Delta Rice Fields" and has a pending proposal with the SWQCB (1,000K), "Developing and Implementing Water Quality BMPs Associated with inDelta Rice Production"</p> <p>Hydrofocus (along with others) is currently funded on a Calfed-DWR proposal (\$740K of total \$3.5 mil), " Learning Laboratory for Restoring Subsided Islands"-project currently on hold. Hydrofocus (along with others) also currently funded (\$486K/2.7mil) out of on a Calfed-DWR "Dissolved organic carbon release from Delta wetlands: amounts, alterations and implications for drinking water quality and the Delta foodweb; part II - fluxes and loads from tidal and nontidal wetlands and from agricultural operations.</p> <p>Is the project team qualified to efficiently and effectively implement the proposed project? I believe</p>
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	<p>that for the most part they are. I would like to see more emphasis in groundwater and interaction with subsurface geology.</p> <p>Do they have available the infrastructure and other aspects of support necessary to accomplish the project? This is difficult to assess. Details regarding the number and placement of InSar data and CMT sites are not specified; and I am not certain that they can be at the proposal stage. They also do not discuss how detailed their groundwater monitoring ability is on the plots of land to be studied.</p>
Rating	excellent

## Budget

Is the budget reasonable and adequate for the work proposed?

Comments	<p>Is the budget reasonable and adequate for the work proposed? Seems appropriately balanced. Perhaps more could be needed in the areas of permitting, groundwater modeling, Glad to see the outreach funded, and amounts there seemed reasonable. Reporting seemed a bit high.</p> <p>They should have enough money to get the data and get it analyzed. To analyze this appropriately you really need to see a work schedule chart by task. A discussion of the schedule is not included in this review, but it probably should be included.</p>
Rating	very good

## Overall

Provide a brief explanation of your summary rating.

Comments	<p>Provide a brief explanation of your summary rating. This is an innovative approach to determine the</p>
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### Technical Review #3

spatial variation in subsidence on a seasonal basis using the new technique of InSar applied with CMT. The technique will be tested on 5 100-acre plots owned by the State that are kept in a fallowed and non-vegetated condition during the study. Groundwater data will also be used to determine its affect on the subsidence process. I believe the authors establishment of the problem and understanding is very good. I believe that good data will come out of this for these local areas. That is the basis for the "Very Good" ranking.

I am concerned that these local areas may not extrapolate to the rest of the Delta and, hence, what is good in theory may not be applicable in practice. Much of the Delta will never be fallow or non-vegetated. Most of the Delta is in a dynamic agricultural status. In much of the Delta we will not have detailed groundwater data. There is no attempt to utilize continuously monitoring GPS systems to provide "ground-truth data" (as opposed to this remotely sensed data) in order to provide a base level control. Why wasn't the study expanded to include additional 100-acre test plots near the proposed plots, that would not be fallowed or where groundwater data would not be available in order to attempt some calibration (i.e., make a step out of the test-control and into the real world)? Based on these concerns I rank the proposal a "Fair" to "Good".

The authors do not discuss or discount the effect of groundwater pumping on producing subsidence. If groundwater is not the source of water for rice flooding then it should have been stated. But the relationship between groundwater withdrawal and subsidence is well-known. Not dealing with this in the proposal left this reviewer with some unanswered questions.

Now having bashed this proposal for some technical shortcomings. I think that good will come from this

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	work and that a spatial baseline to define the subsidence process needs to be established and that this is a technique that could possible do just that. For this importance, I give this overall proposal a ranking of "Good to Very Good"
<b>Rating</b>	very good